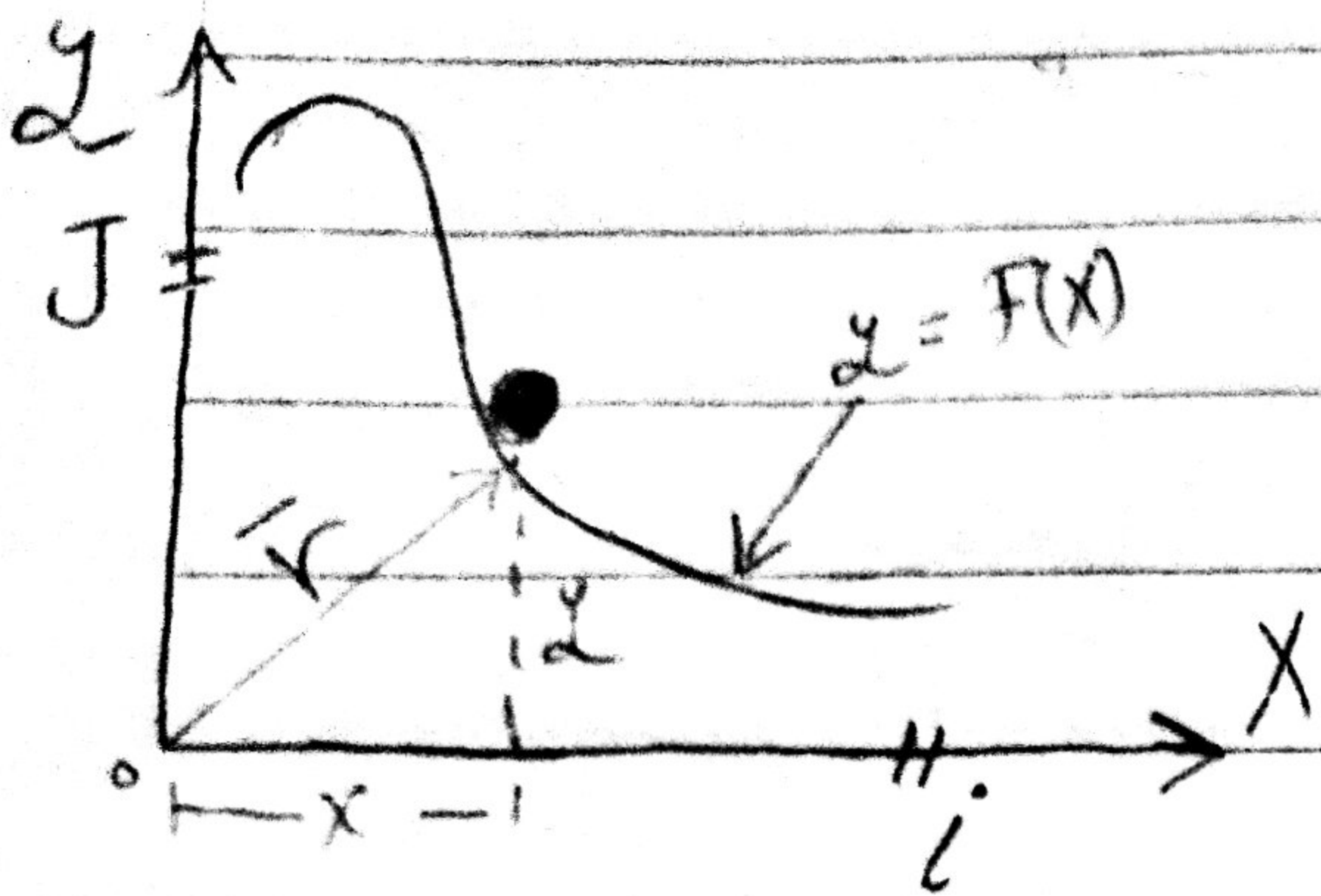


## الباب الأول

## الحركة في المستوى

## 1- الاحداثيات الكارتيزية -

الموضع  $\vec{r}$  :

$$\vec{r} = x\hat{i} + y\hat{j}$$

$$x = F(t)$$

$$y = F(t)$$

لازم تكون  $\hat{i}$  :

متجه سرعة المصير :

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j}$$

$$\vec{v} = v_x\hat{i} + v_y\hat{j}$$

$$v = \sqrt{v_x^2 + v_y^2}$$

$$\tan \theta = \frac{v_y}{v_x}$$

متجه العجل  $\vec{a}$  :

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{dv_x}{dt}\hat{i} + \frac{dv_y}{dt}\hat{j}$$

$$\vec{a} = a_x\hat{i} + a_y\hat{j}$$

$$a = \sqrt{a_x^2 + a_y^2}$$

$$\tan \theta = \frac{a_y}{a_x}$$



معادلة الحركة  
في بعدين  $x$  و  $y$  بدونه الزمن

EX ⑧

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$$\vec{V} = 2t \hat{i} + 3t^2 \hat{j}$$

$$t=0$$

$$\vec{r}_0 = 5\hat{i} - 8\hat{j}$$

(a) Soln

$$\vec{F} = \frac{d\vec{V}}{dt} = 2\hat{i} + 6t\hat{j}$$

$$F = \sqrt{4 + 36t^2} \quad t = 3 \text{ Sec}$$

$$F = r_r$$

$$\theta = \tan^{-1}(3t) = \tan^{-1}(9) = r_r$$

(b)

$$\vec{V} = \frac{d\vec{r}}{dt} = 2t\hat{i} + 3t^2\hat{j}$$

$$\int d\vec{r} = \int (2t\hat{i} + 3t^2\hat{j}) dt$$

$$\vec{r} = t^2\hat{i} + t^3\hat{j} + \vec{C}$$

$$t=0, \vec{r} = 5\hat{i} - 8\hat{j}$$

$$\vec{C} = 5\hat{i} - 8\hat{j}$$

$$\vec{r} = (t^2 + 5)\hat{i} + (t^3 - 8)\hat{j}$$

$$\vec{r}_{t=3} = 14\hat{i} + 19\hat{j}$$

(a)

$$x = t^2 + 5 \quad (1)$$

$$y = t^3 - 8 \quad (2)$$

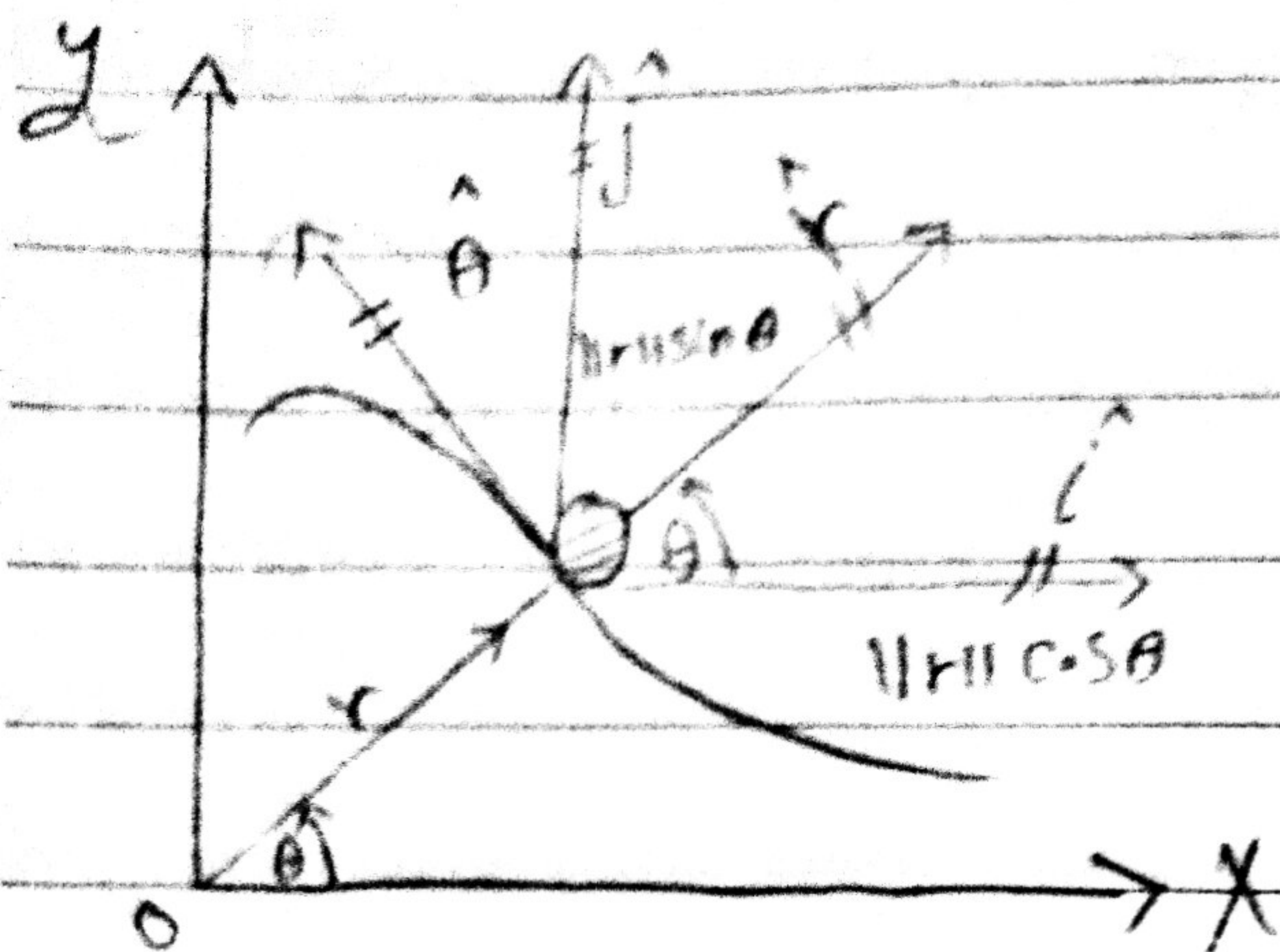
من (1)

$$t = (x - 5)^{\frac{1}{2}}$$

$$y = (x - 5)^{\frac{3}{2}} - 8$$



# الحسابات القطبية



$$r = f(t)$$

الموضع

$$\theta = f(t)$$

$$\vec{r} = r \hat{r}$$

$$\hat{r} = \cos\theta \hat{i} + \sin\theta \hat{j}$$

$$\hat{\theta} = -\sin\theta \hat{i} + \cos\theta \hat{j}$$

$$\frac{d\hat{\theta}}{dt} = -\cos\theta \frac{d\theta}{dt} \hat{i} + -\sin\theta \frac{d\theta}{dt} \hat{j}$$

$$= -\frac{d\theta}{dt} (\cos\theta \hat{i} + \sin\theta \hat{j}) = -\theta' \hat{r}$$

السرعة

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$$= \frac{dr}{dt} \hat{r} + r \frac{d\hat{r}}{dt}$$

$$\frac{d\hat{r}}{dt} = -\sin\theta \frac{d\theta}{dt} \hat{i} + \cos\theta \frac{d\theta}{dt} \hat{j}$$

$$= \frac{d\theta}{dt} (-\sin\theta \hat{i} + \cos\theta \hat{j})$$

$$\frac{d\hat{r}}{dt} = \theta' \hat{\theta}$$

$$\vec{v} = \dot{r} \hat{r} + r \theta' \hat{\theta}$$

$$= v_r \hat{r} + v_\theta \hat{\theta}$$

$$v_r = \dot{r} \quad v_\theta = r \theta'$$



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$$\bar{F} = \frac{d\bar{v}}{dt} = \frac{d}{dt} (r^{\circ} \hat{r} + r \theta^{\circ} \hat{\theta})$$

$$= r^{\circ\circ} \hat{r} + \theta^{\circ} \hat{\theta} r^{\circ} + r^{\circ} \theta^{\circ} \hat{\theta} + r \theta^{\circ\circ} \hat{\theta} + r \theta^{\circ} \frac{d\hat{\theta}}{dt}$$

$$= r^{\circ\circ} \hat{r} + 2r^{\circ} \theta^{\circ} \hat{\theta} + r \theta^{\circ\circ} \hat{\theta} - r \theta^{\circ^2} \hat{r}$$

$$\bar{F} = (r^{\circ\circ} - r \theta^{\circ^2}) \hat{r} + (r \theta^{\circ\circ} + 2r^{\circ} \theta^{\circ}) \hat{\theta}$$

$$F_r = r^{\circ\circ} - r \theta^{\circ^2}$$

$$F_{\theta} = r \theta^{\circ\circ} + 2r^{\circ} \theta^{\circ}$$



Date:

Subject:

EX (10)

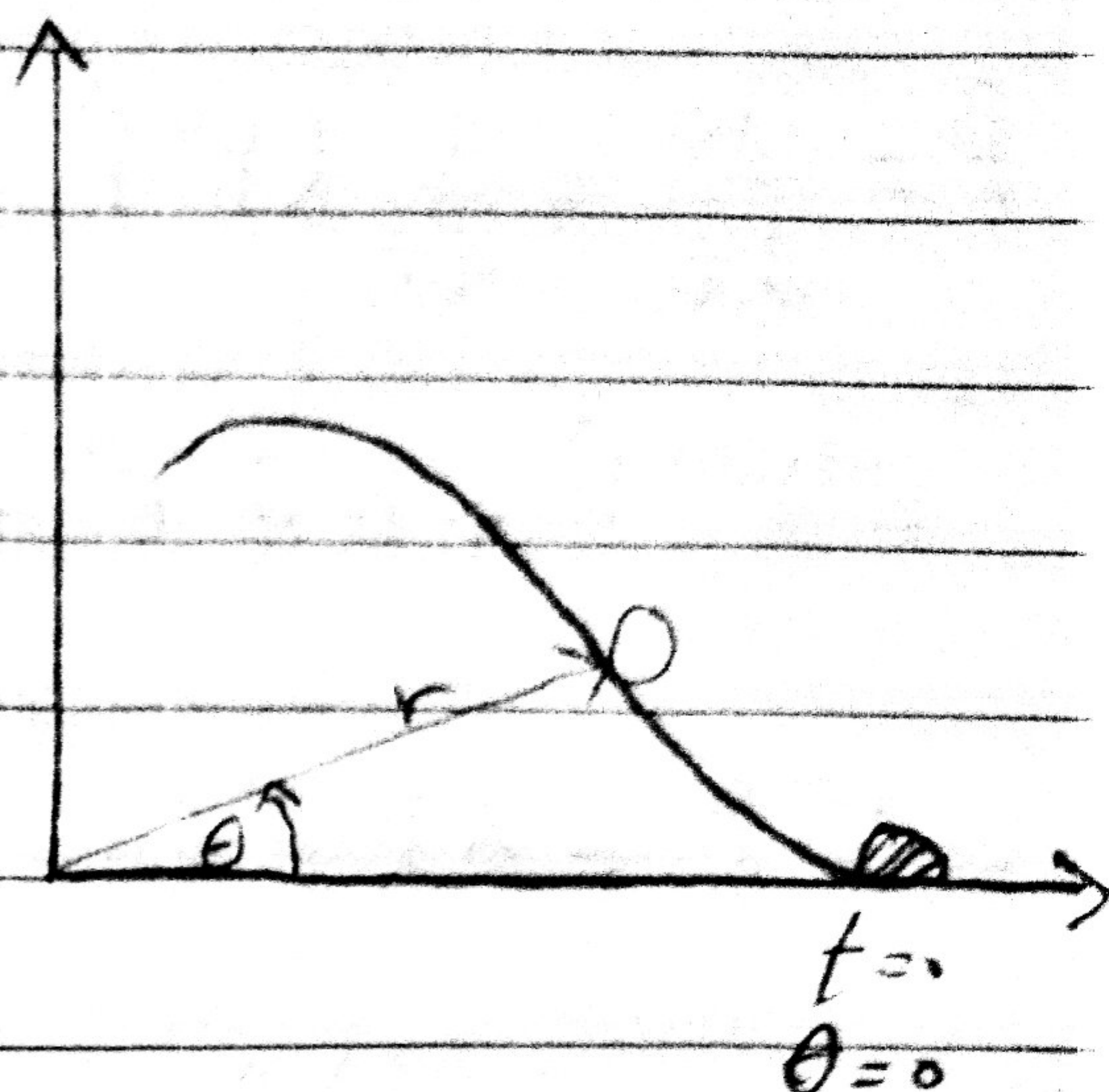
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$$r = a + b\theta$$

$$V \text{ or } F = F(t)$$

$$t = 0$$

$$\theta = 0$$



S. h

$$\omega = \frac{d\theta}{dt}$$

$$\int d\theta = \int \omega dt$$

$$\theta = \omega t + C \quad t=0, \theta=0$$

$$\theta = \omega t$$

$$r = a + b\theta, \theta = \omega t$$

$$r = a + b\omega t$$

$$r^{\circ} = b\omega$$

$$\theta^{\circ} = \omega$$

$$r^{\circ\circ} = 0$$

$$\theta^{\circ\circ} = 0$$

$$V_r = r^{\circ}$$

$$V_{\theta} = r\theta^{\circ}$$

مركبات السرعة

$$V_r = b\omega$$

$$V_{\theta} = \omega(a + b\omega t)$$

$$V = \sqrt{V_r^2 + V_{\theta}^2}$$

مركبات القوة

$$F_r = 0 - (a + b\omega t)\omega^2$$

$$F_{\theta} = 0 + 2b\omega^2$$

$$F = \sqrt{F_r^2 + F_{\theta}^2}$$